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TOWARD AN ASSESSMENT OF TECHNOLOGY GAMING

James A. Dewar

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INTRODUCTION

The questions I was asked to address were: What are the acknowledged limitations of traditional technology forecasting and other methods of assessing the future? Which of these limitations might technology gaming overcome?

Because I had difficulty thinking about those questions, I have rephrased them as follows: What is it that technology gaming hopes to accomplish? How does it compare with other methods of doing the same or similar things?

In the Pace/Moran article in the Naval Engineering Journal,[2] technology gaming is described as a means of guiding decisions relating to the investment of Department of Defense research and development resources. As my point of reference, I will discuss technology gaming in the more restrictive sense that it was used in the Technology Initiatives Game in 1988 (TIG-88). Here I would claim it was focused (within the research and development resources) specifically on the technology base investments--that is, on basic research (DoD budget category 6.1) and exploratory development (6.2). My reasoning here is that the time frame (2010 and beyond) puts it beyond the concerns of advanced exploratory development (6.3A).

The distinction is important because time is a very important element in thinking about the future. Let me first describe a framework for thinking about the future and then use that to discuss various means for dealing with the future.

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[1]This paper was requested by and prepared for the Technology Initiatives Game (TIG-89) held July 16-21, 1989 at the Naval War College in Newport, R.I.

[2]Pace, Dale K. and David D. Moran, "Technology Gaming," *Naval Engineers Journal*, May 1989.

FRAMEWORK

In the best of worlds, our national security today would be maintained by military systems (plus policy, doctrine, training, maintenance, etc.) developed with technologies that had been optimized for today's national security environment. This statement contains both of the foundations for the framework I want to use in thinking about technology gaming. The first is that there are at least three important elements to keep in mind when thinking about technology and its contribution to national security: (1) the technology itself, (2) the military systems (and their operations) into which it is incorporated, and (3) the national security environment in which those systems need to be prepared to operate.

The second foundation has to do with time. The idealized goal of technology gaming and similar methods is to select technologies today for development such that--in retrospect, from some point in the future--we would say that they were exactly the right technologies to have been working on in order to maximize our national security at that point. This carries with it the inherent difficulty in picking technologies today for a future about which we have uncertainty. Further, the more embryonic (and uncertain) the technology the more profound the uncertainty about its future role.

Budget categories 6.1, 6.2, and 6.3A are specifically related to time in the sense that they are related to technological research that is not expected to appear in operational systems until sometime in the future. Further, they are ordered in time, with 6.3A research expected to appear in the field earlier than 6.2 and that, in turn, expected earlier than 6.1 work. None of this is controversial until one tries to put actual time frames on when work in these categories will show up in the field. So let me do that. I will say that 6.3A work begun today will generally not be mature enough to show up in fielded systems for 5 to 15 years. Research in category 6.2 will not be ready for 10 to 30 years, and 6.1 work for 20 to 50 years. It is in this context that I say TIG-88 focused on research in categories 6.2 and 6.1 with an emphasis on 6.2. (This is also compatible with the specific 6.2 focus

of TIG-89.) The framework for thinking about technology gaming now looks as follows with the vertical axis double labeled for emphasis:

Methodologically, each of these boxes needs to be considered separately. For example, the best way to think about technology in the 10- to 30-year time frame may not be the best way to think about it in the 20- to 50-year frame, and so forth.

Admittedly, there are other factors one might consider (notably cost), but I think this framework will illuminate the major differences among competing methodologies.

What follows will not be comprehensive. It is a start at characterizing methodologies for dealing with military technologies and the future. Let me begin by distinguishing between *methods* for dealing with the future and *methodologies* for dealing with military technologies and the future.

METHODS FOR DEALING WITH THE FUTURE

There are four major methods for dealing with any of the boxes in the framework: (1) trend extrapolation, (2) modelling, (3) expert opinion, and (4) scenario writing.

Although any of the four may be used in any of the boxes, I would like to suggest that they are roughly ordered by appropriateness from upper left to lower right in the framework. That is, trend extrapolation is commonly used for understanding technology in the 5- to 15-year time frame and not particularly well-suited for understanding

	technology	systems/ operations	environment	
6.3A				5 to 15 years
6.2				10 to 30 years
6.1				20 to 50 years

Fig. 1--Framework for comparing methodologies

the national security environment in 20 to 50 years. Scenario writing (which includes good and bad science fiction), on the other hand, is perhaps the most popular method for dealing with the state of the world 20 to 50 years in the future.

METHODOLOGIES FOR DEALING WITH MILITARY TECHNOLOGY AND THE FUTURE

In my definition, methodologies are collections of methods applied in various combinations to cover boxes in the framework. The ideal methodology for dealing with military technology and the future would cover all of the boxes in the framework well. Because of the inherent difficulty in doing so, most methodologies cover the boxes unevenly. This section is a first cut at the methodologies that I know of and describes both the *methods* they appear to use and the boxes I would say they cover best.

I will discuss four types of methodologies and will label them as follows:

- pure technology forecasting
- breakthrough technology forecasting
- mission area analysis
- technology gaming.

Pure Technology Forecasting

This is a well-established field (with which I have only passing familiarity) and is based primarily on trend extrapolation. Typical methods include S-shaped logistic growth curves and Gompertz schemes.

These methodologies are primarily oriented toward the technology dimension of the framework with little consideration of systems/operational concerns and even less of the world environment. They do a relatively better job in the near term (5 to 15 years) but are one way of dealing with the far term (20 to 50 years). For relatively mature technologies, their predictive accuracy in the far term might be quite good.

Breakthrough Technology Forecasting

I put into this category the type of forecasting effort spawned by Theodore Von Karman's "Toward New Horizons" study after World War II. It has also been described as 'technology push" oriented and is generally an attempt to pick promising technologies (e.g., atomic fission or computing) that could provide a dramatic increase in military capability. Recent examples of this methodology include Project Forecast II (done by the Air Force), Navy 21 and the ongoing STAR (Strategic Technologies for the Army) study. Typically these methodologies rely on expert opinion (the creative wisdom of the best scientific and technological minds) with trend extrapolation and--on occasion--modelling also being used.

The primary thrust of these methodologies is to cover the technology box in the 20- to 50-year frame. Typically they also cover the systems/operations box reasonably well. Just as typically, they do only a cursory job on the environment in that time frame (usually distilled into a collection of desired military capabilities). There is also an almost inevitable spillover in these efforts into the same boxes in the 6.2 or 10- to 30-year time frame so that it is the bottom left four boxes that are best covered by these methodologies.

Mission Area Analysis

For many years Air Force Systems Command did their investment planning through a system called Vanguard. It is the model for this methodology. It was mission-oriented and used trend extrapolation to discern the requirements levied by the future national security environment. It then used expert opinion and some modelling to come up with technologies and systems to satisfy those requirements. It went on to cost and rank order the systems and to establish a budget-constrained plan for the technology base.

This methodology was aimed primarily at the 6.3A budget category. It generally looked out only to about 12 years, but used that forecast to establish guidelines for the 6.2 category resources as well. Its coverage of the future environment was reasonably good given its short

look (5 to 12 years out) and its coverage of technology and systems/operations was quite thorough. In that regard it covered the top three boxes of the framework well and the next three only sparsely.

Technology Gaming

The two technology games with which I am familiar are the TIG-88 and the Emerging Technologies Exercise run by the Army. As I understand them, they use scenario writing to establish the future national security environment and expert opinion with some modelling to explore systems and operations. At least in the Army effort the technology was handled through expert opinion in an earlier segment and brought to the gaming exercise.

These efforts appear aimed primarily at 6.2 category resources and do a good job of covering the boxes in the framework in that area. There is also some spillover into the 6.1 category.

ANALYSIS

The foregoing has been cursory at best and undoubtedly unfair in places if not flat wrong. With a better job of collecting and characterizing methodologies, however, the above framework could provide a basis for comparing the methodologies by their strengths and applicabilities.

For example, if the foregoing were correct, it would suggest that technology gaming covers a slightly different area than other methodologies and does the best among the methodologies at characterizing the systems/operations and the national security environment in the 10- to 30-year time frame.

This is not to say that all questions of methodology would be answered. The framework here does not speak to cost and an important question in any of these methodologies is "How much money should one spend on deciding how to spend one's money?" It also does not speak to service differences. For example, the Navy might be better served by technology gaming because its strengths are in the 6.2 budget category area and the Navy spends relatively more on this category than the other services.

Beyond that, there are questions "internal" to the framework and to the methodologies being characterized. As an example of the former: How well *can* any box in the framework be covered? For example, how well *can* we know the national security environment in 20 to 50 years?

Of the methodologies, one can ask questions such as whether or not the methods chosen are compatible with the boxes being covered. This appears to be the case for the examples in this paper, but it would be glaring, for example, to have a methodology that did trend extrapolation to project a "most likely" national security environment in 20 to 50 years (something I have seen with depressing regularity).

In general, then, this framework is only a start at evaluating methodologies for guiding decisions relating to the investment of research and development resources. If successful, however, it could provide a coherent perspective from which to discuss the remaining questions of methodological preference.